

clusion that our domestic horses have had a multiple origin—have sprung from at least two perfectly distinct sources—we shall probably subsequently come to the further conclusion that our big-headed, big-jointed horses, with well-marked chestnuts on the hind legs, are more intimately related to the wild horse than the small-headed, slender-limbed varieties without chestnuts on the hind legs; that, in fact, the heavy horses, whether found in Europe, Asia, or Africa, and Przewalsky's horse have sprung from the same ancestors.

HIGHER TECHNICAL EDUCATION IN GREAT BRITAIN AND GERMANY.¹

H.M. Consul at Stuttgart, Dr. Frederick Rose, has rendered excellent service to the cause of technical education by the admirable reports which he has from time to time sent to the Foreign Office; but no previous report of his presents such a clear view of the extent of the provisions for technical education in Germany and of the nature of the services which the technical high schools render to the nation as does the one recently published by the Foreign Office.

Dr. Rose is not a mere blind enthusiast for education, unable to see the other factors which have made for the commercial progress of Germany. On the contrary, he gives due weight to the system of protection, the orderly habits inculcated by the universal system of military service, and other matters which contribute in this direction; but after doing this he is still compelled to recognise the great part played by the German technical high schools in the industrial development of the nation.

The object of this article is to compare the condition of technical education in the United Kingdom with the condition in the country with which Dr. Rose deals; unfortunately, the comparison is one calculated to give Englishmen little satisfaction.

In this country we have a fairly large number of technical institutions with many thousands of students; indeed, in numbers only, it is probable that we should compare not unfavourably with our German cousins. But when we look more closely into the statistics we find that in most of these institutions the majority of the students are attending evening classes only, and that of this majority a very large number are engaged in work of an exceedingly elementary character. If one considers the day students and restricts oneself to those who are above the very low minimum age of fifteen, it is found that, counting not merely the technical institutions, but also the universities and university colleges, the total number of day students for the United Kingdom amounted in 1901 to less than 4000. The corresponding total for the German Empire was, in 1902, nearly 15,000.

These figures, as they stand, are sufficient to show how very backward we are in this country in the matter of higher technical education; but, when we bring into the comparison the ages and previous education of the students of the two countries, we see that the above figures by no means adequately show how far we are behind the foreigner in the matter of training. For it must be remembered that, with very few exceptions, all students in German technical high schools commence their studies when they are not less than eighteen years of age, and after passing

with credit a nine years' course of instruction in secondary schools. We may estimate that of the 4000 students over fifteen in institutions in the United Kingdom providing technical education in the daytime, at least 1400—probably considerably more—were under eighteen; this reduces us to 2600 students to compare with the 15,000 of Germany.

Nor is this all; for, while the majority of the German students pursue their course of study for at least three years, and in many cases for four, in this country only a very small proportion proceed beyond two years; thus it was found that in 1901 there were about 400 third or fourth year students taking complete day courses in engineering in the *whole United Kingdom*; at the same time there were in the Berlin Technical High School *alone* more third and fourth year students of engineering than in all the universities and colleges of the United Kingdom put together; moreover, none of these German students were under twenty, while our figures could only be obtained by counting every student of this standing over seventeen.

To what must we attribute our great inferiority in this respect? In the first place to the condition of secondary education in this country; secondly, to the fact that German and American manufacturers believe in technical education, while many of their competitors in this country are still blind to its advantages; and thirdly to the fact that, while our Government contributes with liberality to elementary education, it is exceedingly parsimonious in its dealings with higher education.

First, then, let us look at the question of secondary education. Dr. Rose's report gives an adequate idea of the splendid character of the preliminary training which young Germans receive before they enter the technical high schools or other higher institutions in Germany. The secondary schools to which he refers are accessible to children of intelligence all over the Empire; they are carefully graded so as to overlap one another as little as possible, and every inducement is given to parents to allow their children to pursue a complete course of study. The leaving certificates of these schools confer upon children the right of entry to the universities and technical high schools, while they also form a starting point for those who wish to enter the more important branches of the State service, and confer the right to escape part of the compulsory military training. We may hope that in this country the new education authorities will improve our secondary education. Is it too much to expect that the Government may issue a leaving certificate conferring similar privileges to the German one, and taking the place of the medley of university local, Board of Education, Army, Navy, and Civil Service examinations, and many others, which now hang like mill-stones round the necks of the teachers in secondary schools.

The problem how to make British manufacturers believe in technical education is one which is slowly solving itself, and within the recollection of the present writer an improvement in this direction has taken place. That the improvement has not been more rapid is partly due to the fact that in this country the imperfectly trained student has been over-confident in his own powers to an extent only explicable by considering the shortness and imperfection of his training. The half-educated, college-trained youth has thus often become a laughing-stock in the shops; he has given his opinions freely, and they have not infrequently been wrong.

In some of the best technical institutions we are altering all this; our students are made to understand that the preliminary training they receive is only a preliminary training, enabling them to acquire more complete knowledge later, but not entitling them to

¹ "Report on the German Technical High Schools." By Dr. F. Rose, H.M. Consul, Stuttgart. (No. 591, Miscellaneous Series of Diplomatic and Consular Reports.)

Since this article was written, Lord Rosebery's letter has appeared, foreshadowing the establishment of a technical high school approximately on the Berlin scale in London. But the writer lets the article stand; for one such institution will scarcely suffice for the ultimate needs of the metropolis alone. It may be hoped, however, that similar developments will occur in our other great centres of population.

become critics. Our manufacturers, on the other hand, are learning to value young men who have had a sound training, and it is becoming less and less difficult each year to find suitable places for students of this kind, even though many of the students are prolonging their training longer than was the case some years ago, though still for a far shorter period in most cases than is the case with the German students.

In estimating the amount of assistance which the State gives to higher technical education in this country we are confronted with a serious difficulty, for the institutions in which such education is given are seldom concerned with this work only. The technical institutions spend much of their energy and financial resources on elementary work in evening classes, while in some cases they also include preparatory day departments, which are simply secondary schools of a modern type. In the university colleges which provide higher technical education, such work represents, as a rule, only a small fraction of their activity.

It is, however, quite certain that comparatively little of the grants made to technical institutions and university colleges can be considered as given specifically for higher technical education. Indeed, in so far as the former are concerned, the present policy of the Board of Education is to give high grants for secondary schools and elementary evening classes with numerous pupils, and but little aid to the day classes for adults, which form the most important part of the work of the best technical colleges.

The Scottish Education Department, on the contrary, has recently altered this for Scotland by selecting the institutions at Glasgow, Edinburgh, and Dundee, and putting them in a position of great liberty to develop their higher work, while promising to give aid, not so much for thousands of students doing elementary work as for the high quality of the advanced work done by a smaller number of persons. May we not hope that in England the authorities will soon adopt a similar policy?

As to Germany, Dr. Rose's report mentions the following facts. The Prussian State gave to the Berlin Technical High School alone, in 1871, an annual subvention of 85,111*l.*; this grant has been gradually increased until, in 1899, it amounted to 33,675*l.*, while in the same year the total grant to the three Prussian technical high schools reached the sum of 65,350*l.*, being more than half the total revenues of these institutions. But besides these amounts, sums are independently voted by the Prussian Ministry of Finance towards meeting extraordinary expenses incurred for new buildings, machinery, apparatus, &c. If these sums be taken into consideration, we reach the grand total of 121,348*l.* a year. It must be remembered that these figures relate not to the whole of Germany, but simply to the kingdom of Prussia, with an industrial population many times less than that for which we have to provide leaders in the United Kingdom.

One of the tables in Dr. Rose's report shows in a remarkable way the great progress which has been made in the matter of higher education in Germany since the Franco-Prussian War. For the attendance of students at the German universities, technical, agricultural, and veterinary high schools, &c., has increased from 17,761 in 1870 to 46,520 in 1900; or to state the matter in another way, there were in such institutions in 1870 about nine students for every 10,000 male inhabitants of Germany, while in 1900 there were nearly seventeen students for every 10,000 male inhabitants. The rate of increase has been much more rapid in the technical high schools, though the universities also have made progress; the actual figures given by Dr. Rose are:—for the universities, 13,674 students in 1870, and 32,834 in 1900; for the technical

high schools, 2928 in 1870, and 10,412 in 1900, irrespective in each instance of students in agricultural and mining high schools and other higher institutions. We see, then, that the attendance at the technical high schools has increased nearly fourfold during the thirty years, while in the same period the university students have become only about two and a half times as numerous.

An important point in Dr. Rose's report is that in Germany the technical high schools are independent of universities, although in some of the largest towns, such as Berlin and Munich, universities and technical high schools both flourish, existing side by side, and in some cases apparently overlapping, but not really so doing, since the object of the two institutions is not the same. The university students may be supposed to seek knowledge mainly for its own sake, while students in technical high schools propose to put their knowledge to commercial uses.

There is no doubt that this separation of technical work from the control of the university professors has been a good thing for both classes of institutions, which are now recognised as of equal standing in Germany by the action of the Emperor, as King of Prussia, followed shortly after by the King of Württemberg, whereby the technical high schools have the right of conferring the degree of doctor of engineering, thus putting them on a par with the universities in this respect. This action was taken notwithstanding the strong opposition of the Prussian universities, and the Emperor at the same time admitted the principals of the Prussian technical high schools to the Prussian House of Lords, and bestowed upon each of them the title of "His Magnificence."

Perhaps the most important lesson to be learnt from Dr. Rose's report is the need for the strengthening of the best technical institutions in England which provide for the training in day classes of our industrial leaders.

The report shows that in Germany higher technical education is concentrated in a limited number of institutions, and these the State makes thoroughly efficient. The result is the gathering into a single institution of such a large number of students that it is possible to provide for them buildings, equipment, and teaching staff on a scale far in advance of anything found here. Thus the teaching staff of the three Prussian technical high schools numbered in 1899 no less than 554, being one teacher for each nine students in attendance. This liberal staffing enables the German teachers to specialise, greatly to the advantage of the country, the students, and the teachers themselves. In Germany a man is not—as is the rule here—expected to deal with the whole range of such enormously wide subjects as, *e.g.* electrical engineering. One teacher has a thorough knowledge of central station equipment, another of telephony, a third of electro-motors, a fourth of electro-plating, and so on.

It is evident, then, that, if we wish our higher technical training to be as good as that of the Germans, we must concentrate our students. But this has been difficult, because our technical education has been so largely in the hands of local authorities; these bodies are naturally anxious to give the highest form of training for many industries within their own limits, but they are not, as a rule, willing to expend the very large sums needed to make this possible; nor would such an expenditure be wise. We have, therefore, in the United Kingdom a comparatively large number of institutions each attempting—for the most part inefficiently—to do the highest work in many branches of technology.

If imperial patriotism would but outweigh local partiality, the sums already available might go further

than they do at present to provide better training for our industrial leaders. In London one may hope that this may be effected by inducing certain institutions to specialise in given directions. To take a case in point, the buildings, equipment, and numerical size of the staff of the Central Technical College might be equal to dealing satisfactorily with one branch of engineering or of applied chemistry. At present the college undertakes nearly all branches, and does it remarkably well, considering the difficulties under which it labours. If all the teaching staff for higher work in London were amalgamated, it would still be inferior in quantity—and, probably, in quality for *specialised* work—to that at Berlin; but it would not be, as is at present the case in the more or less isolated institutions, far too small for the work it is trying to do.

In the provinces the problem is more difficult, but not insoluble, if we are all more anxious for the good of the nation than for the glory of our own town or institution. Elementary technical education is needed in all the towns, but technical colleges are wanted in a few great cities only; and even in these populous centres every important branch of technology cannot be taught with efficiency, because, for a long time, there will be too few students to warrant adequate expenditure. Why should Sheffield and Leeds, *e.g.* both attempt the highest work in metallurgy and mining? Might not Sheffield send, say, its mining teachers and students to Leeds for higher work, and Leeds return the compliment by helping to develop the highest possible training in, say, metallurgy at Sheffield?

The case mentioned is only one instance of a principle which the Government ought to seek to establish generally, and to induce local authorities to adopt by offers of suitable grants in aid of what is really a pressing national need, *viz.* the development and improvement of our higher technical training. Each of the great cities might be made a centre for the highest training for one or more of our national industries, and the neighbouring cities should be willing to act as feeders to it in respect of this higher work.

Unless some such policy be adopted, there seems but little chance that we shall ever be able to offer a training equal to that available in Germany. For it would require enormous and wholly unnecessary expenditure to develop into a first-class technical high school dealing with many branches of technology, every technical institution and university college which is at present attempting to give some form of higher technical training.

Above all, let us note that both in Germany and America the flourishing technical colleges are not, as a rule, under the control of the universities, but exist side by side with them as co-equal organisations with different aims. To subordinate higher technical education to ordinary academic control would be to make a mistake which our German and American cousins have carefully avoided. Technical institutions might, however, very well become constituent parts of a university, provided, as has, *e.g.* been arranged at Sheffield, that they retain a sufficient measure of self-government. The scheme of Prof. Riedler, which Dr. Rose quotes with approval, would be a very good basis upon which to make a division between the work of our technical institutions and university colleges which exist in the same area, and, to some extent, overlap one another.

The university college might embrace, as Riedler proposes for the universities of Germany, the faculties of law, theology, medicine, philosophy, languages, history, State science, art, mathematics, and natural science; while the technical institutions would on his plan embrace the faculties of engineering, mining,

forestry, agriculture, military science, and applied chemistry.

Finally, it may be well to quote the words in which Dr. Rose summarises the results of his extensive inquiries:—"The technical high schools cannot boast of the proud traditions of the old universities, nor are their buildings and institutions regarded with those feelings of gratitude and reverence which a long and honourable career in the service of humanity naturally inspires; but in default of this they can point to an almost perfect organisation and equipment for modern requirements, and to a development within the last forty years almost unparalleled in the annals of educational history." May a similar statement be possible ere long in regard to our own higher technical institutions!

J. WERTHEIMER.

THE TENTH "EROS" CIRCULAR.¹

"AS an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but so far as known, only two or three have made the reductions needed to render their observations of any value." So wrote Prof. E. C. Pickering in April, in his "Plan for the Endowment of Astronomical Research"; and he is not alone in asking, directly or indirectly, when we may expect to have the result of all the work done at the opposition of 1900-1. The tenth Eros circular, dated June 1, appears at the right moment as a provisional reply. It gives the results of equatorial observations at twelve observatories, all compared with the ephemeris; and two splendid series of photographic observations made at Bordeaux and Paris, completely reduced so as to show not only the comparison of the planet's place with the ephemeris, but a series of places for individual stars such as has never been given before. If these two observatories had done nothing else in the two years elapsed since the plates were taken, they might be congratulated on a fine piece of work. Other results will doubtless follow now that these are in print to act as an incentive, and we need have no fears for the ultimate result.

It is, however, well to remember that the opposition of Eros came upon us at a time when our hands were already more than full with the ordinary work of the astrophotographic catalogue. It was an embarrassing choice whether to put aside the catalogue measures for a time, to finish them before undertaking the Eros work, or to try to do both simultaneously. The various observatories have selected one or other of these alternatives according to the stage which the catalogue work had reached. At Bordeaux and Paris a leisurely programme has been adopted for this work; the French Government has supplied ample means, but the vote has been spread over twenty-five years, and the work will be extended over the same period. It would have been ridiculous to defer the measurement of the Eros plates for any period of this kind, and we imagine the catalogue work has been put aside in order to measure the Eros plates. At Oxford, to take a different case, the catalogue work has been pushed forward rapidly so as to make the best use of the small sum available, and is on the point of completion. The Eros work can then be taken up without undue delay. At other observatories some compromise has doubtless been adopted between these extreme courses. So long as the work goes forward on the lines of least resistance there is no particular need to be anxious; and we welcome the appearance of the tenth circular as an outward and visible sign of the vitality of this research, which some were beginning to accuse of hibernation.

¹ Conférence Astrophotographique Internationale de Juillet 1900. Circulaire No. 10. Pp. 318 Paris, 1903.)